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C-ROM Bios Ver 1.1

Users Manual

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1. Introduction

This is the user manual for the Costgold Research Ltd CA856 and CA866 16 bit 80-BUS processor cards when fitted with the C-ROM Bios firmware. The C-ROM Bios is contained in a 2764 type of EPROM.

The C-ROM Bios gives a Costgold Research CA856 or CA866 card the ability to load and run a wide range of commercially available operating systems for Intel 8088/8086 based computers. This is done by providing a terminal emulation program for an IBM PC or equivalent computer, together with a set of ROM based programs for general I/O including disc, printer, serial port and real time clock. These calls use the now industry standard interface of the IBM PC.

The installation of this card in an existing 80-BUS computer system will enable it to run the Microsoft MS-DOS operating system, and a wide range of software available for this operating system.

It should be noted that if an application program does not use the ROM Bios interface, then it may not function correctly. Generally, however, a wide range of software is available for MS-DOS computers in a "generic" form (ie not specifically IBM), with terminal configuration programs.

This document does not attempt to describe the operating system features and facilities in any way, and before the system is used it is vital that the user should carefully study all the operating system guides and then read this document to ascertain the differences between the normal operation of the system and its implementation on an 80-BUS computer.

The recommended minimum configuration for operation is as follows:

a. Costgold Research CA856 or CA866 card.

b. At least 128k of RAM.

c. Gemini IVC/SVC display card.

d. GM852/GM827 Keyboard or similar.

e. Gemini Floppy Disc Controller Card (with SCSI interface if hard disc is to be used).

f. At least one and preferably two 40 or 80 track drives. These may be mixed.

g. A hard disc is recommended for all MS-DOS applications.

The C-ROM Bios will support a wide range of PC compatible operating systems (excluding Digital Research CPM/86 for the PC and CCPM/86 for the PC). A special version of CP/M-86 for use with the CA856 or CA866 is available from Gemini Computer Systems Limited.

The ROM bios will allow the operating system to be booted and run, using 40 track single or double sided systems discs. An 80 track to 40 track emulation is provided. Using the PR Utilities pack from Costgold Research the following additional features are provided.

a. Emulation of PC function keys.

b. Use of CA856/866 on-board clock to provide system date and time.

c. Formatting of 80 track single and double sided discs in an MS-DOS compatible format.

d. Full use of an 80 track drive via a "Device Driver".

e. Control of the memory control for screen width.

f. Selection of 3 millisecond/6 millisecond stepping.

g. Selection of single stepping/double stepping.

2. Installation

The CA856/866 may be installed in a wide variety of systems. It is important that the following description of modes of operation is carefully read, and all the implications for the system being employed are fully understood.

2.1 Modes of Operation

This describes the different operational modes which may be used with the CA856 when it is installed in a Gemini system. There are three different modes:

Mode A. - Dual Processor Mode (Slave CA 856)

Mode B. - CA 856 Master Mode

Mode C. - CA 856 Standalone Mode

These modes of operation must be selected at installation, and require the fitting of a number of link options to select the operational modes.

The modes of operation rely on the presence on the 80-BUS of two control lines - BUSREQ, which is an active low signal which may be used to signal to the current bus master that it should release the bus and go into an "idle" state, and BAI (which is an abbreviation for Bus Acknowledge In) which is a signal from the bus master to the requesting bus master that the bus is available and that it may start using the bus for its own purposes. These two signals are "active low", in that they are a low voltage output when they are actually in their active state. For further information on these signals see the GM811, GM813 Hardware Reference Manual.

2.2 Selection of Modes

The modes are controlled by two links. Both these links are placed between A56 and A57 which is the Real Time Clock chip in the top left hand corner.

Link "g" is used to select modes.

OPEN (as shipped) selects Modes B or C.

CLOSED (ie shorted to ground) selects Mode A.

Link "i" is only used in Mode A. Until it has been shorted to ground the 8088 will not request the 80-BUS. See also link "l" in the description of Mode A below.

Mode A. - Dual Processor Mode

It is difficult to arrange that the Z-80 processor may easily switch in and out for the following reasons:

a. The CA 856 has its own internal RAM, and when executing a program from this RAM the 80-BUS is not refreshed. This means that very rapidly the contents of the 80-BUS dynamic ram become corrupted, and so it is necessary to re-boot CP/M-80.

b. The Z-80 processor cards do not have multi-bus master operation designed in, and so it is not possible to arrange to swap from one card to another.

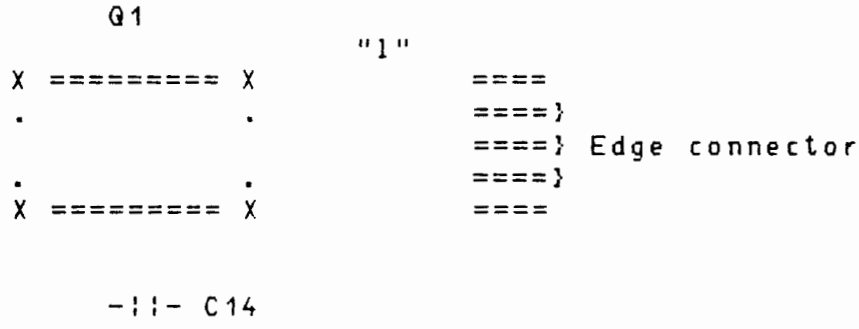
c. The Reset control circuitry of the Z-80 processor cards does not allow them to be reset whilst the Z80 is disabled by the 8088 processor of the CA 856.

To allow easy use of the Z80 processor the following procedure must be adopted:

Set Link g on the CA 856 to select Mode A. This requires the link to be fitted.

Link i is then used to flag the processor that it may commence execution and take control of the bus from the Z80 card. To signal this, the link input must be shorted to ground. It is suggested that the 'Aux' output of the GM 811/GM 813 is used for this. This is next to the 5 pin DIN socket and the pin nearest the edge of the board should be connected to the hole immediately next to the resistor R6 on the GM 856/866.

Link l, the link that controls the state of the Busreq line at power up must be connected as shown:



Please note that the default position of the link is vertical, and it is necessary to break the tracks on the reverse side of the card from the components.

At power up or reset the Z80 will run, and attempt to boot off the disc. If the boot fails it will enter RPM if this is available and this will allow the user to enter the following commands to select the CA856:

```
<rpm_prompt>* obc 0
```

This will enable the /OUT1 output of the 8250, which will in turn activate the AUX output drive transistor. If this has been connected to the "i" input link of the CA 856 it will then signal the 8088 to request the bus and continue its processing.

It is also possible to write a very simple program which would allow the Z-80 to switch itself out - see Appendix A.

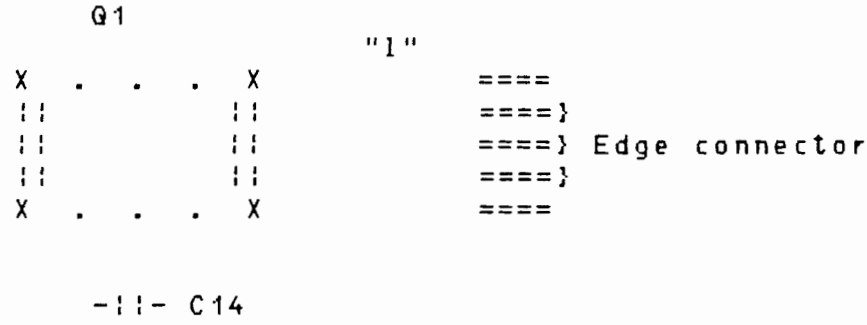
Mode B. - CA856 Master Mode

In this mode the CA 856 will gain control of the bus automatically at reset. The Z-80 processor will never run. However, its IO may be accessed and so the serial and parallel port may be used.

The Z-80 also provides the system clock.

The following link positions should be set.

Link "1" (See Mode A for location)



Link "g" and "i" are ignored in this mode.

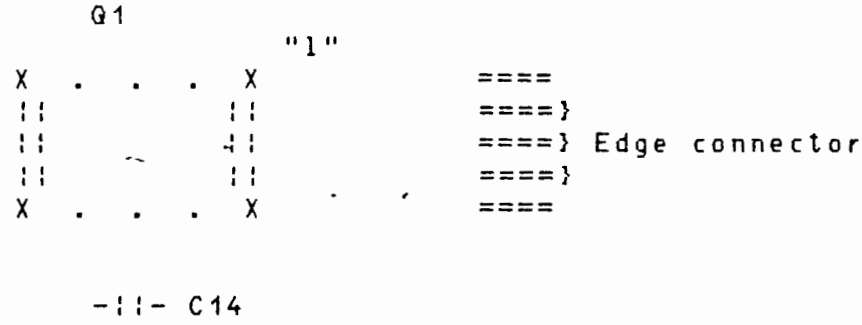
Link "d" and "j" must be open (this is the normal shipping mode for these links).

Mode C. - CA856 Standalone

In this mode the CA856 may be run as the sole processor in the system. To allow this, the 8088 card must provide the system clock and also the /BAI signal in must be made active (ie low).

Link positions are thus:

Link "l" (See Mode A for location)



Link "g" and "i" are ignored in this mode.

Link "d" must be connected. This will connect /BAI to link "m".

Link "m" must be connected. This will ground /BAI.

Link "j" must be connected. This will connect the on-board 4MHz clock to the 80-BUS. This is needed for the FDCC and the display cards.

3. System Operation

After selecting the appropriate operating mode, and carefully installing the card in the system, operation may be commenced. It is important to note that if the card is being used in either Mode A or Mode B it must be placed so that its BUSREQ line will automatically hold the Z-80 processor at power up.

When power is applied to the system, the display should blank, and the display card initialisation message should appear:

"IVC 2.0 etc"

(The exact message depends upon whether the system has an IVC or SVC and which version of the display card firmware is fitted.)

If the system is in Mode A, then the normal GM813 operationg will then ensue. This will continue until the Mode A change link (link i on the CA856/866 is shorted to ground). The CA856/866 will then exert a BUSREQ and take control of the system. This will then be followed by the normal CA856/866 sign-on message.

In the case of Mode B and Mode C the CA856/866 will immediately take control of the system after power-up or when the reset button is pressed.

The processor then performs a system initialisation and a complete memory test. The memory test enables it to determine the amount of system memory available. The C-ROM Bios itself requires some of the system memory for its operation, and this is reserved after the maximum size of memory has been found.

At least 64kbytes of RAM must be found in the system. However the maximum amount of RAM in the system may be much more than this - for use with MS-DOS a minimum suggested amount of RAM is 192k bytes.

The standard CA856 is provided with 256k bytes of RAM. Where the CA866 is employed it is possible to a mix of dynamic and static RAM. The RAM check program at power up requires these to be in 8k contiguous increments if all the memory is to be available to the operating system.

3.1 System Boot Up Procedure

Upon the successful completion of the memory test the C-ROM Bios will look for an operating system. This may be either on floppy or hard disc, if a hard disc is provided. To distinguish between the Version 3.1 and earlier Costgold Research Limited CP/M-86, and a PC compatible operating system the following procedure is adopted:

1. The A: drive is selected, and an attempt is made to read the first track of the first side starting at sector 0. If this succeeds, then the second track of the first side will be loaded in to memory, and if the code bytes at the beginning of the disc correspond to the Costgold Research CP/M-86 operating system then execution will commence at 1000:0.

2. If step 1. fails, then an attempt will be made to read sector 1 of the first track of the first side into memory. If this is successful, then this will be executed. This would be the boot sector of the MS-DOS or PC-DOS operating system if the disc was a systems disc for one of these operating systems.

3. If step 2. fails, then the hard disc will be accessed. Firstly, the first sector of the hard disc is read into memory. This contains a special control byte which establishes what kind of hard disc system is incorporated. If the hard disc has not previously been used or has just been "hard formatted", then this control byte will not be in a valid range. In this case, the user is prompted to select the appropriate Winchester type supported.

BE CAREFUL - this menu is only offered once, and if the wrong type of drive is selected, then it will be necessary to reformat the Winchester entirely.

4. If step 3. fails then an error message is printed, and the user must select an operating system diskette,place this in drive A: and press the reset button.

3.2 Use of C-ROM Bios with PC compatible software

A standard distribution copy of the operating system will load correctly but to obtain the full use of the system, the reader is referred to the section about the special Device Drivers available from Costgold Research which allow extra facilities.

An important point is that time/date stamping of files is not supported unless the Real Time clock chip driver is incorporated.

Once the operating system is loaded careful reference should be made to the specific operating system manual for specific variations.

3.3 Use of C-ROM Bios with CP/M-86

A special form of CP/M-86 is available from Costgold Research for use with the C-ROM Bios. Updates to existing versions of CP/M-86 are available from Costgold Research Ltd, either direct or via the normal distribution channels.

Version 1.1 of the C-ROM Bios does not support CP/M-86 for the IBM PC, or CCP/M-86.

3.4 Operation With Floppy Discs

The standard C-ROM Bios can directly interface with up to two floppy disc drives. These floppy disc drives may be configured by software to have the following features:

a. 40 Track

b. 80 Track

c. 80 Track Double Stepping (ie 40 track emulation)

c. Single Sided

d. Double Sided

e. 3 millisecond step rate

f. 6 millisecond step rate

The C-ROM Bios will automatically assume that the system uses 80 track drives, but converts all track references to 40 track media, so providing direct PC compatibility. Special device drivers are available to allow the reconfiguration of the system in any other required format. See the section on Device Drivers and the Programmers Utilities.

3.5 Operation with hard discs

B A C K U P Y O U R H A R D D I S C F I R S T !

The control software for the hard disc is fully "compatible" and can drive hard discs of up to 60 Megabytes physical capacity. The hard disc may be split into up to four partitions, where these partitions are controlled by a special table at the end of the first sector of the hard disc. Each entry in this table defines the start and end logical sector number of the partition. These entries may be accessed by the operating system "FDISK" program. NOTE: where the system is already created for a CP/M system a special version of the CP/M Bios must be obtained to allow both MS-DOS and CP/M to "co-exist" on the disc at the same time. Please contact your dealer for this and related information. This applies to both CP/M-80 and CP/M-86 operating systems.

For a hard disc to be used in the system it is necessary for the relevant control information for the hard disc to be generated to initialise the hard disc controller. This information is identified to the C-ROM Bios by a byte at the beginning of the disc control table. After this byte has been set it may only be reset by reformatting the disc. Care should be exercised when setting up the hard disc partitions. Particularly, it is important that all information on the hard disc is saved BEFORE any attempt is made to install the new operating system!

3.6 A Method for Installing a Hard Disc partition

A possible method for installing a hard disc partition on a system which already has CP/M information on it is now described. This has one drawback. After this is complete, the CP/M may only be booted from floppy disc, and the MS-DOS will be booted up if no floppy based operating system is found.

B A C K U P Y O U R H A R D D I S C F I R S T !

1. Using CPM utilities, create two (or more) CPM directories where one of these directories is the size you would like your MS-DOS partition to be. Calculate start and end cylinder numbers.

2. Install the CA856. Boot the system. This will prompt you with a menu to specify the drive type which you should now do.

3. Using the MS-DOS utility FDISK, create a partition which has the same start and end cylinder numbers as in 1.

4. This will have become the MS-DOS hard disc directory C:. With the standard MS-DOS operating system this will be up to 10 MB. Using a Costgold device driver it may be made bigger than this.

5. Copy back your CPM information to the CPM directories.

6. You will now no longer be able to access the CPM directory which corresponds to your MS-DOS C: drive. If you do, you will corrupt your MS-DOS information. It is suggested that when you create the original CP/M drive for this purpose you choose a drive identifier you have never used before to help minimise mistakes.

4. Special Device Drivers and Special Software

An important feature of MS-DOS 2.0 and greater is the ability to generate special systems by loading a special program into memory called a Device Driver. These programs are capable of being incorporated into the operating system, and allow the re-direction of console commands, serial and parallel port accesses etc.

The Device Drivers are placed in a special system configuration file called CONFIG.SYS, which must be present on the same disc as the operating system when the system is being booted. For further information on Device Drivers, refer to MS-DOS technical reference sources and the Programmers Utility Pack Users Manual.

Two device drivers currently available are COSTCLOK.SYS which allows the use of the on-board HM46818 clock to generate system date and time, and GEM80XX.SYS which allows the use of an 80 track diskette in Drive B: (as Drive D:) where XX is DS for double sided drives and SS for single sided drives.

Three other programs are available:

TEAC.COM - configures the system for use with 80 track Teac and other 3ms step rate drives.

PCROTKEY.COM - provides an emulation for IBM PC special function keys.

S80.COM - sets a byte value used by many applications programs at the beginning of memory to a value which indicates that the screen is 80 columns wide.

5. Limitations and incompatibilities

The major problem of compatibility is with the rather unusual screen format of the PC. This uses a memory mapped display with a lot of rather clever features, all of which are particularly difficult to emulate with an IVC or SVC!

C-ROM Bios emulates the PC display by directly accessing the IVC/SVC display memory to enable a reasonable simulation of the monochrome display adapter mode. To establish which programs will run, and which ones will not, it is necessary to experiment!

However many MS-DOS programs are available in a generic MS-DOS form, and these may be run. In this case, it is normally more effective to use their terminal configuration software to directly use the Gemini IVC/SVC control codes.

The IBM PC has the bulk of its BASIC contained within an EPROM which is part of the memory map of the PC. This is obviously not the case with the Costgold Research CA856/856, but many of the "compatibles" have an entirely disc based version of BASIC. These generally work with the following points to be borne in mind.

a. When using the IVC/SVC as a display emulator none of the colour and graphics related commands are supported.

b. The serial comms functions are only partially supported as they bypass the Rom Bios on the PC.

Some utilities (including even some IBM utilities!) don't access control parameters via the software interrupts as they should do, but directly modify control fields in the area of memory used as a "scratch pad" by the PC firmware (400H to 4FFH). The most notable example of this is the screen width control. A utility in the Programmers Utilities pack allows this to be directly set to the required 80. Otherwise Debug may be used. The location of this (WORD) variable is 44AH (absolute address).

6. Hardware Interfacing Information

This section describes the way in which hardware interface programs may access the hardware. There are three major considerations, the memory map, the IO map and interrupts.

6.1 Memory Map

In the CA856 the memory map is split into two portions - the RAM map, which is contigous from 0, and the ROM map, which starts at the last 8k of memory (for the CA856). The memory map for the on-board RAM extends to 256kbytes. At power up the initialisation program performs a complete RAM check starting at 1000:0 until it finds an error on an 8k boundary. When this happens, it assumes that the end of memory has been found. An 8k boundary is used because the same program is used in the CA866 which may have 8k RAM chips fitted.

To allow the system to be PC-compatible at boot time the C-ROM Bios "cheats", in that the memory available to the operating system is less than the actual memory found. It is made less so that a scratch area is available for special control fields and an entire "Track Format Buffer" is available for supporting the "Track Format" function of the Disc Services Interrupt (INT 13H). This is not necessary normally because the disc drive controllers used in "compatibles" employ a different principle when formatting blank diskettes.

This memory value is saved in a control register and may be accessed via the MEM_SIZE software interrupt (INT 12H) which returns the number of kbytes of RAM in AX. This figure returned will not, however, be the total RAM but the modified value as described above. This may be easily seen by booting the sytem, at which point the free memory found is displayed in the sign-on message, and then executing the CHKDSK function which will show a figure approximately 8k bytes smaller.

For those programmers who are interested in knowing obscure things about the system, the segment used by C-ROM Bios for data operations (ie the value to which the DS segment register is set to) is stored as the first word of the 4 byte software interrupt ODOH (address 4 * ODOH = 360H). If this value is altered any access to C-ROM Bios will crash horribly, so be warned!

This value may be used to determine the amount of memory in the system, but the INT 12H function is to be preferred!

6.2 The Input/Output (IO) Map

The IO map is as below:

Address	Function
0000	Real Time Clock Chip (HM 46818)
⋮	
003FH	
0040H	System Control Port (Write)
⋮	System Data Port (Read)
⋮	
007FH	
0080H	On Board UART (INS8250)
⋮	
00BFH	
00C0H	Not used
⋮	
FEFFH	
FF00H	Maps to 80-BUS IO
⋮	
FFFFH	

The on-board IO is mapped in 64 byte steps. Only the RTC chip is thus fully decoded. The system control port is a single bit port. It is used to control the setting of the BUSREQ line. Bit 0 of this port is BUSREQ, of outputting Bit 0 as 1 will release the bus to the Z80 processor (if present).

Any user program running in the CA856 may then execute as long as it does not attempt an 80-BUS access. Setting Port 40H Bit 0 to 0 will "freeze" the Z-80 processor.

The on-board UART is a National Semiconductor INS 8250.

The on-board Real Time Clock chip is a Hitachi HM 46818.

The relevant technical information for these devices should be studied.

The 80-BUS IO is accessible as the top 256 IO ports in the address map. To access these ports the equivalent 80-BUS IO port address should have 0FF00H added to it (remember the 8088 can address up to 65536 IO ports).

e.g the address of the GM813 UART is 0B8H when accessed by the GM813 but this becomes 0FFB8H when accessed by the CA856.

6.3 On-board Interrupts

It is possible for the CA856/866 to respond to interrupts from either the Uart or the RTC chip. A simple interrupt structure is provided which uses an LS244 as a very simple control device (A52). This port is activated on to the local address bus whenever the 8088 issues an /INTA instruction ("Not Interrupt Acknowledge"). However, to employ an interrupt service routine is unfortunately slightly complicated by the limitations of the hardware. To understand the following explanation it is advised that an Intel technical manual is studied to fully appreciate the workings of an 8088 when responding to an interrupt.

In essence, the 8088 responds to an interrupt request by issuing an interrupt acknowledge, which is a special kind of READ cycle. It then expects to see the lower 8 bits of the data bus active with the interrupt vector number. This vector number is multiplied by four to give the absolute address in low memory of the interrupt vector. This address is then read and interpreted as the offset and segment of the interrupt service routine.

In the case of the CA856/866 the interrupt requests from the UART and RTC form the two least significant bits of the vector created by A52 when it is strobed by /INTA. The complication is that the RTC interrupt is active low, and the UART interrupt is active high. Also, if both devices are interrupt driven, there will be three possible interrupt vectors generated, and the interrupt handler software must be capable of accepting all three vectors and deciding which one should be responded to. The vectors generated are as follows:

Vector	RTC	UART
2CH	Yes	No
2EH	Yes	Yes
2FH	No	Yes

where "Yes" means that if this vector is encountered the corresponding device has generated an interrupt request.

6.4 Software Interrupts supported by C-ROM Bios

The following software interrupts are supported by the C-Rom Bios V1.1.

"Compatible"

Vector	Function
10H	Video Services
11H	Equipment Interrupt
12H	Memory Size
13H	Disc interface (floppy and hard disc)
14H	Serial Port
16H	Keyboard
17H	Printer
19H	System boot

Note that currently the two unsupported interrupts are the "Print Screen" function and the "Time of Day" interrupt.

6.4.1 Parallel Printer

The Printer function (INT 16H) uses the parallel port on the GM813 (if this is fitted). The interface is Gemini compatible Centronics.

6.4.2 Serial Interface

Up to 8 serial ports may be provided. At initialisation the C-ROM Bios looks for two ports, one at 080H (the on-board port) and one at 0FFB8H (the GM813 UART). If either of these is found an entry in a control table is marked accordingly. This control table is held in RAM, and if it is wished to access any other INS8250 UARTS via MS-DOS "COMMn:" function, it is possible to modify the table to introduce the device to the C-ROM Bios. Please contact your distributor if you wish to do this.

The on-board INS8250 is COMM1: and the GM813 port is COMM2: if an MS-DOS operating system is used.

6.4.3 Version Number

If a feature of the C-ROM Bios is intended to be incorporated into an application program, then the version number of the C-ROM Bios should be checked. This is held as a packed BCD value at the absolute address 0FE00:0. For version 1.1 this is expressed as "11H". (Version 1.0 didn't have this feature.)

Appendix A - Bibliography

For systems programmers who wish to investigate the features of the operating system more closely the folowing books are recommended.

1. The Programmers Guide to the IBM PC

Peter Norton
Microsoft Press ISBN 0-14-087-144-6

2. Programmers Guide to MS-DOS

Jump
Brady Communications ISBN 0-8359-5655-5

3. IBM Personal Computer Disk Operating System Technical Reference by Microsoft Corp.

Appendix B - A Mode Change Program

It may be more convenient for the user to have a simple CPM-80 program to allow the 8088 to run where the system is in "Mode A".

This program must prompt the operator to insert an appropriate MS-DOS or CP/M-86 systems disc in drive A. Then it must issue the appropriate port command (this assumes that link "i" on the CA 856 is connected to the AUX pin on the CA 856).

Where the system has a hard disc it is not necessary to insert a systems disc as C-ROM-Bios ver 1.1 and greater will automatically boot off a hard disc if this is available.

```
                ORG 100H
        bdos    equ     0005H   ; System entry point


        mvi     c, 9            ; Print message requesting
        lxi     d, sys$msg      ; systems disc
        call    bdos

        mvi     c, 1            ; Await any key
        call    bdos

        mvi     a, 0
        out     0BCH            ; Output byte

        mvi     c, 0
        call    bdos            ; Shouldn't be necessary

sys$msg:        db      0dh, 0ah, ' Please insert CA 856 system disc'
                db      ' and press any key$'

        end
```

Appendix C - Disc Drive Controls

There are two aspects of the floppy disc interface which may be controlled by software. These are:

a. The setting of the single/double step flag

b. The setting of the 3 millisecond/ 6 millisecond step flag.

The actual flag settings apply to all system floppy drives simultaneously. This is because they are intended to be used by any block device driver which is written for multiple configurations of floppy. In practical terms this is almost essential as it is almost impossible to access any other size of drive other than the standard 40 track IBM drive without first providing a suitable block device driver to tell the operating system the various drive parameters.

The disc drive controls are accessed via software interrupts. For a full understanding of what a software interrupt is it is necessary to read the appropriate Intel technical documentation. A software interrupt on an 8088/8086 behaves very much like an RST instruction on the Z-80, allowing access to code in a specified place with a call from anywhere in the memory map.

There are two disc drive control interrupts:

GET$CONTROLS - Interrupt 0D1H.

This returns the current setting of the controls:-

AH = TRUE means that double stepping is selected.
FALSE means that single stepping is selected.

AL = TRUE means that 3 millisecond stepping will occur.
FALSE means that 6 millisecond stepping will occur.

SET$CONTROLS - Interrupt 0D2H.

This will configure the controls as required. The controls are set into the AX register as defined above, and then the interrupt is invoked.

e.g. To set the floppy disc interface to single stepping but not affect the step rate control.

```
<previous>      ; AX will be modified
INT  0D1H       ; Get current setting of controls to AX
MOV  AH, 0      ; Clear control to single stepping
INT  0D2H       ; Set current value of AX into controls
<continue>
```